RECYCLING IN ALBERTA

Alberta
ENVIRONMENT
Environmental Protection Services
Pollution Control Division
Waste Management Branch

88-00489/

RECYCLING IN ALBERTA: AN OUTLINE

Albertans — industry, agriculture and private households — produce over 10 million tonnes of solid wastes every year. This amount of waste cannot be allowed to accumulate haphazardly. Something must be done with it. Not only is disposing of waste a problem, but valuable resources can be lost in process. Some form of management is necessary to deal with the problems of disposal, health hazards, energy and material losses and environmental damage which can result from the volume of wastes we produce. Solid waste management involves collection, storage, handling, processing, disposal and recycling of all solid wastes.

Current waste management practices continue to pose significant problems for our environment and for our lifestyles. Disposal sites are often sources of pollution. Resources are wasted when recyclable or re-useable material is burned or buried. Locating sites on which to dispose of wastes is becoming a problem for many municipalities.

The Government of Alberta recognizes these several areas where our solid waste management practices need to be altered for the better. Consequently Alberta Environment has a Waste Management Branch whose mandate includes studies for change and improvement in these areas.

The reclaiming or recycling of more of our solid wastes may offer some of the very best hopes for alleviating many of the problems. This booklet on the recycling of solid wastes is therefore published by the Waste Management Branch as a contribution toward more informed public participation in solid waste management processes. The material in this booklet was prepared by Rob and Joan Pritchard.

JANUARY 1979
REPRINTED MARCH 1985
REVISED NOVEMBER 1986

Printed on Partially Recycled Paper.

A Glossary of Recycling Terms

This is a list of terms and their meanings as they are commonly used in the discussion of recycling.

Some more specific terms are defined as footnotes throughout this booklet.

compost organic material which has decayed into a rich earthy material

fermentation the processing of organic material into a variety of chemical products through the biological action of certain micro-organisms

organic material any matter which is derived from living or previously living tissue, plant or animal

pollution the discharge of a foreign substance, or abnormal amounts of a natural substance, into the natural environment

pyrolysis a high temperature process for the treatment of organic wastes, in the absence of air, to produce various oils, gases and other chemicals

raw material any material from which a product is made

recycle to convert used materials into raw materials for the production of new products

recyclable in a form which can be recycled

refuse discarded solid waste materials, commonly referred to as garbage

refuse-derived fuel a solid fuel produced by shredding and drying the organic portion of municipal refuse

resource any material which may be useful

- **renewable resource** a resource such as trees or fresh water, which is continuously produced in nature (although not necessarily at the same rate as it is used)
- **non-renewable resource** a resource which, once extracted from the earth, cannot be replaced
- **primary resource** a resource which is extracted from its natural source, for example, iron ore, petroleum, trees
- **secondary resource** a resource which has already been used, but can be a valuable substitute for a primary resource as a raw material in the manufacture of new products
- **recovered resource** a used material which is collected after use, or recovered from a mixture of wastes, for use as a raw material

re-use to use another time; refers to items which can be used a number of times in the same form (eg. pop bottles)

salvage to recover a material or item from waste

Contents

Problems and Solutions 5
Paper 9
Glass 11
Metals 12
Lubricating Oils 14
Organics 16
Plastic 19
Rubber 20
Cloth 20
Barriers to Recycling in Alberta 21
Where Do We Go From Here? 22
For Further Information 24

Problems and Solutions

"There is no need to argue whether we should or should not recycle. Recycling is actually all we can do on this finite planet; whether we dump it, burn it, or pump it down the drain, nothing ever gets lost! It merely changes into other forms and it remains forever a part of the environment!"

DR KARL SCHULZE ENVIRONMENTAL SCIENTIST

Recycling is a process as old as nature itself. Growth and change are possible only because earth's finite[1] resources are constantly being recycled. Everything, from individual elements such as carbon and oxygen to mountain rock, is recycled in nature, providing examples of efficiency which modern man would be well advised to follow.

Our Rocky Mountains are one of the grandest displays of recycling on a massive scale which nature can provide. Several hundred million years ago, ancient rock was worn down by erosion and washed to the sea by rivers and streams. This silt combined with the remains of animals and plants as sediment in prehistoric North America's inland seas and eventually hardened into rock which was then pushed up by geologic forces to become the Rocky Mountains. Even today the Rockies are being eroded and washed to sea, where the settling sediment is slowly hardening, possibly to be raised to new mountains many millions of years in the future.

The carbon cycle is an example of the recycling of an individual element. Carbon, one of the essential building blocks of all life on this planet, is extremely useful in nature's scheme of things, and nature uses it very efficiently. Carbon exists in the atmosphere as carbon dioxide, an invisible and odourless gas. Plants absorb carbon dioxide from the air and utilize the carbon to create carbohydrates[2] (sugar, starch, cellulose, etc.) which forms the cell matter of plants. When an animal eats the plant, the carbohydrates are digested and absorbed into the body in many forms. Throughout the animal's body certain carbohydrates are oxidized, producing carbon dioxide and providing energy for movement and body heat. The carbon dioxide is exhaled from the animals lungs back into the atmosphere. When either plants or animals die the carbohydrates in their tissues decompose through microbial[3] action. This process also returns carbon dioxide to the atmosphere. From the atmosphere to living tissue and back to the atmosphere - this cycle will repeat itself endlessly as long as life exists.

Nature wastes nothing. Since no matter is ever destroyed, everything will eventually be recycled. This may occur within the lifetime of a blade of grass, as with carbon, or within geologic ages. Nothing is ever lost to nature, but man can lose many valuable resources if materials which were once useful to him are converted to forms which are not. Tin cans or paper buried in a landfill[4] will eventually decompose. Although returned to nature, they are, for our purposes, wasted. But instead of landfilling[5] them, we can convert these and other materials to forms which will be useful again -- by recycling.

Although man's recycling efforts will never be on as massive a scale as mountain building, or as efficient as the carbon cycle, there are several approaches we can take to the

1 Finite - having a definite limit

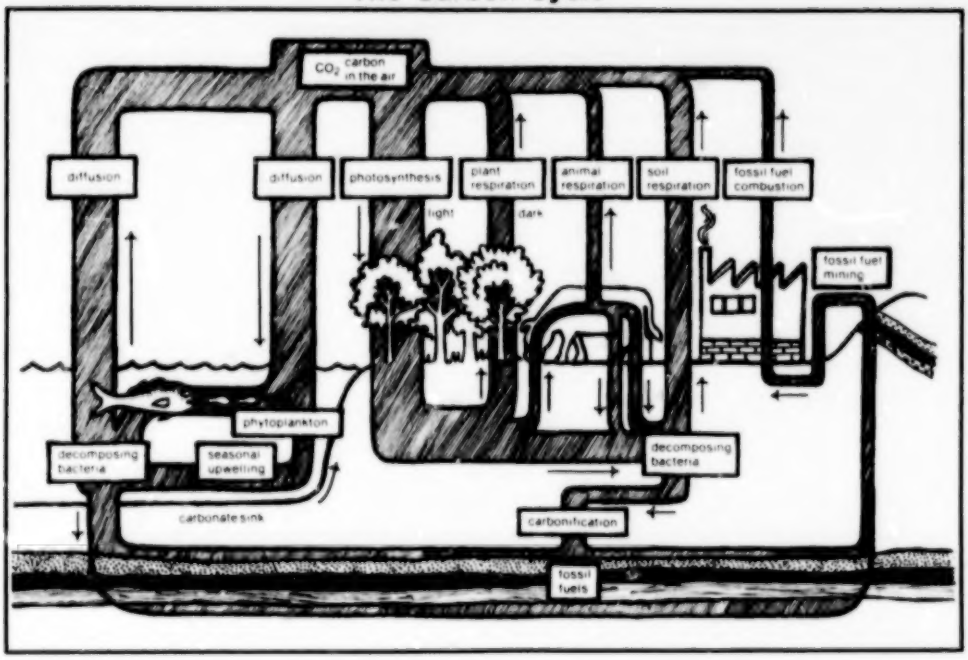
2 Carbohydrate - any organic compound produced by plants from carbon, oxygen and hydrogen, includes sugars and starches

3 Microbial - by the action of micro-organisms such as bacteria

4 Landfill - a site where refuse is buried

5 Landfilling - burying refuse in the ground as a means of disposal

The Carbon Cycle



recycling of our resources. Let us look at three ways in which man can recycle one of his man-made materials -- glass. The most efficient means of keeping the glass in circulation is to actually re-use the glass items for their original purpose. An example would be washing out a pop bottle and refilling it with pop, or using an old jam jar to store nuts and bolts. The second most efficient way is to crush up some clean bottles and jars and melt them down to make glass for new bottles and jars. The third way to make use of glass is to crush it very fine and make use of its properties other than those which make it good for bottles and jars. For example, finely crushed glass has been substituted for sand in things like road pavement or concrete, because of its strength and heat conduction properties.

There are many good reasons for recycling, most of which are basically questions of waste -- the waste of energy, resources, money and environmental quality. Resources which are used once, then disposed of as garbage, are wasted if they could have been recycled for future use. A large landfill, or for that matter several smaller ones, is a waste of land if recycling could have reduced the volume of garbage to be buried. Money is wasted on the collection and disposal of excess refuse. The processing of natural raw materials often generates a lot of pollution and requires considerable energy, while recycling generally uses much less energy and creates less pollution. Failing to recycle means wasting the energy which could have been saved. As well as factory-produced pollution, there is often damage to the environment associated with obtaining new raw materials. Many mining and forest harvesting operations leave ugly, longlasting scars on the landscape. Recycling can help reduce the number and size of these. The less we waste, the fewer problems we create.

However, recycling is not the first step toward reducing waste -- it is actually one of the last. Steps that come before recycling include: designing products so that they can be repaired more easily and last longer; designing them to be more easily recycled after use; eliminating unnecessary packaging; and not buying unnecessary and wasteful items. Separating useful materials and saving them for recycling rather than throwing them out with the garbage is an important step toward efficient recycling.

The Solid Waste Problem

Each person in Alberta discards an average of 1 kilogram (2½ pounds) of household refuse each day. That is over 400 kilograms (900 pounds) per person per year, or almost 2 tonnes per year for a family of four! In all, household refuse is about 50 percent paper, 30 percent food waste, 8 percent metals and 2 percent glass. The remainder includes leather, dirt, ceramics and plastics.

At the present time, most of this refuse is collected and hauled away to a disposal site where it is either burned or buried. Collecting all that refuse is expensive and burning refuse causes air pollution. Poor landfill operations can also pollute groundwater. The more refuse we make, the more it will cost and the more pollution it might cause.

The Energy Problem

Since energy savings are one of the stronger arguments in favour of recycling, let us look at the question of energy in our society as a whole. Energy has become very important to our way of life. It is needed to drive our cars, transport our goods, heat our homes, cook our food, manufacture the fertilizers used to grow our food, and for many other purposes which support our way of life.

The most common forms of energy used in Alberta are electricity, natural gas, petroleum products and coal.

While hydro-electricity, generated by falling water, is a very long term supply of energy, about 75 percent of the electricity consumed in Alberta today is thermal electricity, which is produced by burning a fuel to create steam and then using the steam to drive a turbine. This is an extremely inefficient process because about 70 percent of the energy in the fuel is lost. Examples of thermal electricity generating stations in Alberta are the plant at Lake Wabamun, which burns coal, and the Rossdale Flats plant in Edmonton, which burns natural gas.

Considerable quantities of petroleum, known as "crude oil", are refined in Alberta to create a range of petroleum products. Common fuels from this source are gasoline, diesel fuel, airplane fuel, heating oil, naptha and propane. Other petroleum products include lubricating oils, paraffin and asphalt. Alberta's coal, which is also in abundant supply, is a good fuel that generates a lot of heat, but while low in sulphur, it also generates a lot of smoke and fly ash[6]. Coal burning plants must have equipment to collect the smoke and ash before it escapes into the atmosphere.

There is much speculation today that world supplies of petroleum and natural gas may soon run out at the current rate of consumption. We would then no longer have these as fuels. This would be disastrous from another point of view. Petroleum products and natural gas are also needed as chemicals for use in the manufacture of a large number of drugs, plastics, cleaning solvents, pesticides, fertilizers, and many other important products. It can be argued that our way of life may depend more on petroleum as a source for these other products than for our fuels. Perhaps we should try to conserve[7] our petroleum for the chemically-derived products and substitute other sources of energy wherever possible.

Solving the Problems

Increased recycling is one way to reduce the problems associated with solid waste disposal[8] and our energy use. Recycling can reduce the quantity of solid waste which must be handled. Recycling will reduce the tremendous wastage of resources and energy that burying vast quantities of useful material represents. Recycling will also reduce the pollution and other environmental damage associated with production and processing of raw materials.

We are already doing a lot of recycling. Scrap dealers in Alberta recycle tonnes of

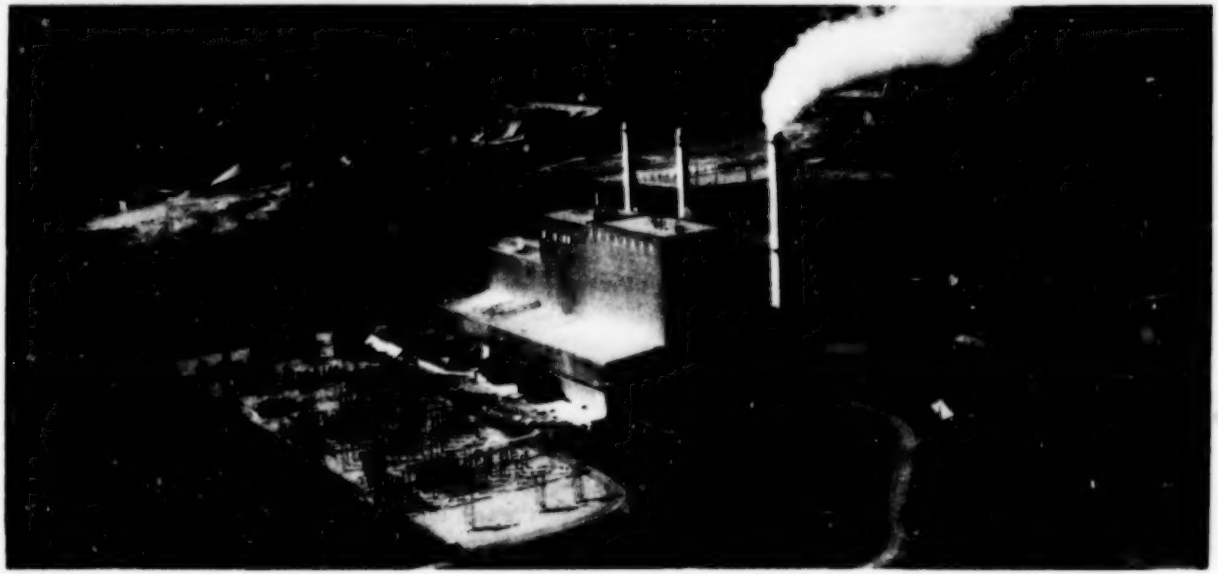
6 Fly Ash - fine particles of ash found in smoke from burning products

7 Conserve - to save for the future by preventing waste today

8 Waste disposal - an attempt to permanently remove waste materials from man's immediate environment

Imperial Oil Refinery, East Edmonton

Calgary power plant at Wabamun Lake



used metal every year to steel mills. Paper dealers in Edmonton and Calgary recycle many paper products. Soft drink manufacturers re-use their bottles, and liquor and wine bottles are crushed and made into new glass plant near Medicine Hat. There are still 400 million kilograms (900 million pounds) of paper thrown out by Alberta households every year, as well as 70 million kilograms (150 million pounds) of cans and other metals, and 11 million kilograms (25 million pounds) of glass and 6 million kilograms (15 million pounds) of plastic. In addition to this, there is all of the paper discarded from offices and schools, cans and glass from restaurants and other food services, and wood and metal from construction sites. Also, there are tons of solid organic matter from forest-based industries and from agriculture being wasted every year. They could be used for energy. We have a long way to go towards really efficient use of our resources, and we should do our part to help Alberta society to move in that direction. Recycling will conserve resources, save energy, reduce pollution and stop wasteful disposal practices.

Paper

Paper[1] as we know it today was invented in China in 105 A.D. From this beginning, as a substitute for silk as a writing material, paper expanded in its use and is now employed for so many purposes -- everything from facial tissues to packing cases, disposable diapers to paper plates -- that is now comprises about 40 percent of everything we throw away.

The first paper was made by Tsai Lun from the fibres[2] taken from the inner bark of a mulberry tree. Paper can be made of a wide variety of fibres but today most paper products are made from wood. In making paper, wood chips are broken down into fibres, either by grinding or with chemicals, into soupy mixture with water known as pulp[3]. The process of making paper from pulp essentially involves spreading the pulp on a screen, then removing the water by a number of processes involving suction, squeezing and heating. After the water is removed, paper is left on the screen.

The process for recycling paper was invented in 1800 by Matthias Koops. He discovered that pulp could be made by disintegrating used paper in hot water. However, the idea did not catch on very well at that time, although to this day the small amount of paper recycling that is done uses Matthias Koops' process. In fact the paper made by Matthias Koops in 1800 is in very good condition today (still flexible after 170 years). This is proof that paper made from used paper pulp can be just as good as paper made from wood pulp.

In recycling, however, an important factor is the grade of paper. For example, newsprint and cardboard are made from a different kind of pulp than is high quality printing paper. It is possible to recycle newspaper and cardboard to make more newspaper and cardboard but it is not possible to make high quality printing paper from newspaper and cardboard. Therefore, it is necessary to be able to recognize the different kinds of used paper and to keep them separate in order to make the best use of them when recycling.

Used paper of all kinds, whether it is newspaper or high quality printing paper, generally contains impurities, such as dyes and ink. These must be removed from the used paper pulp if it is to be used to make more pure white paper. The reason given by the paper making industry for not making more use of used paper pulp is that the cleaning, bleaching[4] and deinking[5] operations that are necessary are complicated and expensive processes. There is no process being used in Alberta today for the bleaching or deinking of used paper pulp. Consequently, there is no paper being made in Alberta today from used paper.

Not all uses of waste paper requires bleaching or deinking however. If the pulp is not bleached or deinked it can still be used to make writing paper of good quality, though discoloured and spotty instead of pristine white. Apparently paper manufacturers feel that

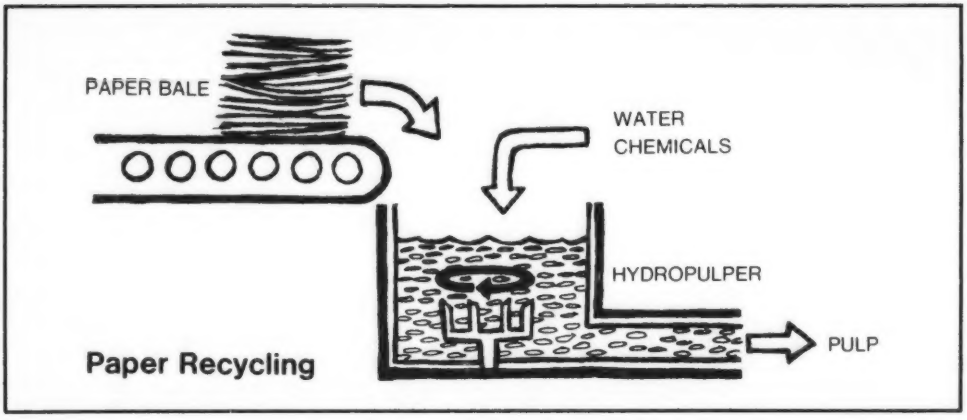
1 Paper - matted sheets of vegetable fibres, usually wood fibres, which are used for writing and printing.

2 Fibres - the threadlike component of vegetable matter.

3 Pulp - a soupy mixture of vegetable fibres suspended in water and chemicals, from which paper and paper products are made.

4 Bleaching - the removal of colours, whitening.

5 Deinking - the removal of ink from used paper.



Paper Recycling

this kind of writing paper will not be purchased by customers even if it is cheaper, so no one in Canada today manufactures this good quality, recycled, discoloured writing paper.

Most recycled paper is being used in Alberta today for certain building materials such as roofing shingles, drywall, tar paper and insulation materials. For these purposes the used paper also does not need to be bleached or deinked because the colour of the product is not an important factor. Some of the higher quality used paper collected for recycling in Alberta is used for the smooth outer surface of drywall board, while some newsprint and computer tab cards are being exported. Technology in the paper-making field is developing rapidly and it may not be too long before the manufacture of paper with at least some recycled fibre will be practiced in Alberta.

There are certain kinds of paper products[6] which are very difficult or impossible to recycle because of their nature. Among these are paper products coated with materials that can not be removed during the pulping process. Some examples are milk cartons coated with wax, carbon paper, and papers coated with metal foil.

But why should we recycle paper at all? Some people will say that trees are a renewable resource. As long as we plant trees as fast as we cut them down to make paper there should be no problem -- we will never run out of trees. Also it must be cheaper to make paper out of trees than to make paper from used paper because most of the big paper companies are doing it that way.

Those who argue that trees are a renewable resource are correct. As long as we plant as many trees as we cut down we will never run out of trees. However, many people feel that a natural forest is much more pleasing than a forest which has been cut down and replanted. Also, many ecologists feel that there is considerable damage done to the environment after all the trees have been cut down before the new trees have grown up again.

From an economic point of view, companies that make paper from trees receive certain tax advantages which other companies that salvage and recycle paper do not receive. From an energy point of view, it takes considerably more energy to make pulp from trees than to make the equal amount of pulp from used paper. As energy prices rise and as the economy changes, we may find it cheaper to recycle paper than to continue cutting down trees to make paper, using the paper once and then paying to dispose of it. As this happens, it will become more economical to separate paper in the home, at school and at the office, and save it for recycling. This would be even more efficient if high quality papers, such as used good white writing papers, were kept separate from lower quality papers. Any large-scale increase in recycling will require people to spend a few more seconds thinking about what they are throwing away.

6 Paper Product - any product made out of paper, or in a similar manner, including corrugated cardboard, kleenex, paper cups, etc

The major raw material used for making glass is sand. Most manufacturers use a small amount of broken glass in each batch of new glass. This broken glass is known as cullet[1].

Cullet is used mainly because it melts at a lower temperature than the raw materials used in making glass and this helps the mixture to melt more quickly. Also, using cullet makes finished glass more uniform. Most glass manufacturers make their own cullet from glass manufactured in their plant. In this way they can guarantee the quality and the content of the cullet.

Almost all of the glass used in the home today can be recycled. One very efficient form of recycling is re-use, such as returning a soft drink bottle to the bottler to be cleaned and filled again. This works very well for soft drinks because there are bottlers in all large municipalities. It would be less economical for glass jars or bottles filled and sealed at a central plant and shipped for long distances. Items which are not re-used, such as jam jars

1 Cullet - broken glass, used as an ingredient in the manufacture of new glass.

and ketchup bottles can be crushed and used as cullet. It is technically possible to make glass from 100 percent glass.

There are two reasons why more glass is not being recycled in Alberta today. The first reason is supply. Glass manufacturers must be certain the cullet they are using is pure. Glass cullet cannot contain any impurities[2] such as pieces of plastic or metal, or pieces of other kinds of glass (for example - the bottle glass used in making jam jars is different from plate glass used for making windows, so clear bottle glass cullet cannot contain any broken window glass). The second problem is transportation. If a clean supply of clear glass cullet can be collected, it must then be transported to the glass manufacturing plant, which can be very far away.

Many glass manufacturers once thought that using glass cullet leads to an inferior colour in the glass. It was formerly thought that to make green glass, for example, only green glass cullet could be used. This is not true. Recent tests in California have shown that cullet made from a mixture of different coloured glass can be used in quantities as high as 20% in making new coloured glass without detracting from the quality of the colour. New developments such as this may encourage the use of more used glass cullet by glass manufacturers.

Glass can be used for a variety of things other than making new glass. Clear glass can be used for making the miniature glass beads added to the reflective paint for highway markings and road signs. Crushed glass can also be used in the same manner as sand in concrete, asphalt, bricks or a number of other products. Crushed glass imparts excellent qualities to these materials because it is strong and has better heat transfer properties than sand.

There are processes which use crushed glass as a raw material to manufacture other products such as spun glass insulation, building panels and floor tiles. Most of these processes are still in experimental stages in the United States. A firm in Germany is now manufacturing fiberglass insulation from old glass.

But why are we interested in recycling glass at all? There is certainly no shortage of sand in Alberta. The best reason for recycling glass is that it takes less energy to make glass from cullet than to make glass from raw materials. Remember that cullet melts at a lower temperature than the normal raw materials used for making glass. Using cullet speeds up the melting process which saves energy and reduces costs. It makes the new glass produced more uniform and stronger. Finally any glass that is recycled will not have to be handled by our normal garbage collection and disposal facilities.

Technically there are a wide variety of ways in which glass can be recycled. The problems are ones of collecting enough glass of a suitable quality and transporting it to the plant where it can be used, and of encouraging manufacturers to use more cullet.

2 Impurities - undesirable substances contained in any material.

Metals

Recycling of metals is already an important industry in Alberta. There are about 40 scrap[1] dealers who buy used metal for recycling, and 7 scrap metal processing companies which use scrap metal as a raw material. These companies recycle over 430,000 tonnes of metal every year, most of it from commercial sources.

Household garbage is generally about eight percent metal, most of it in the form of "tin" cans. These cans are made from tinplate which is steel with only a very thin layer of tin. Tinplate is used because it resists corrosion.[2] Thus the can lasts a long time and so does the food it protects. Some cans, particularly those having removeable snap tabs or punch holes on their ends, are made with aluminum ends. Aluminum is much softer than

1 Scrap - recovered steel, iron or other metal objects, intended for recycling.

2 Corrosion - the eating away of or gradual disintegration, as by acid or rust.

steel making the can easy to open.

Steel is an alloy[3], the principal ingredient of which is iron. Fresh steel is made by melting iron then adding carbon and some other metallic or non-metallic elements. These additives give the steel certain properties, such as hardness, strength, flexibility or corrosion resistance. For some kinds of steel, such as that used in airplane construction, it is very important that the added ingredients be precisely controlled, so that the steel produced is exactly as required. However, for many kinds of steel, such as rods used for reinforcing concrete, the exact composition of the steel is not as important. This kind of steel can easily be made by recycling used steel.

Tin is an undesirable element in scrap steel for recycling. Cans made from tinplate contain too much tin for them to be used, except in small quantities, in making recycled steel. Thus, if cans are to be recycled, the tin must be removed. There is a successful process for detinning[4], but it is very expensive and requires large amounts of tinplate to justify building a plant, even though the tin which is recovered can be used to make more tinplate.

Another problem is created by aluminum-ended, snap-top tin cans. Aluminum not only creates a problem to steel recycling, it also creates a problem in the detinning process. Aluminum-ended cans must first have the aluminum, then the tin removed before recycling.

Shredded cans may be used in a certain process of extracting copper from copper ore. This process requires a source of iron, and the tin does not hinder the process. However, the tin is wasted when cans are used in this way. In the absence of either a detinning process or one of these copper refining processes, tin cans are really not of much use.

Tin and aluminum are very valuable in themselves. Tin is a scarce metal. Known supplies of tin are being rapidly depleted. It makes sense to recover as much tin as we can instead of throwing it into garbage dumps.

The simplest solution to all of these problems may be to stop using cans that are made from two or three different kinds of metal. Some manufacturers are experimenting with cans that do not use tin. Their cans have coatings of chromium (which is much less of a problem to steel recycling) or resin[5] instead of tin. Unfortunately, these are not yet being widely used.

Used appliances and junked cars are two other kinds of used metal that are produced by households. About 60% of the cars which are junked in Alberta every year are recycled through scrap dealers. The rest of the cars, along with almost all of the old stoves, refrigerators and other appliances, are dumped in landfills. The biggest problem with recycling cars and appliances is similar to the problem with tin cans. They are made from steel combined with many other materials which are hard to separate. Cars contain glass, plastic, upholstery, rubber and metals such as aluminum, copper and chromium. Appliances are usually coated with ceramic and contain electric motors full of copper wiring. The steel can be separated from the other material by shredding and magnetic separation. At the present time, there is one scrap dealer in Alberta with shredding equipment. Other dealers ship compacted car bodies to shredding facilities in Manitoba and Saskatchewan.

Why recycle metals at all? First, as with paper and glass, there is an energy consideration. Recycling metal consumes much less energy than making metal from ores. Steel made from recycled scrap uses only one-quarter of the energy needed to make steel from iron ore. Aluminum can be recycled at a saving of 95% of the energy used to manufacture aluminum from aluminum ore. It also requires a lot of energy to mine ores. Processing ore to get the metal out often causes considerable pollution. Recycling metal causes much less pollution. In addition to these considerations, many of the supplies of available ores are being rapidly depleted. It is not a question of "running out" of certain metals, but metals can be extracted economically only where they are available in sufficient concen-

3 Alloy - a metallic substance obtained by mixing a metal with other metals or non-metals.

4 Detinning - a process for the recycling of tin-plate, whereby the tin is removed from the steel.

5 Resin - an inert varnish-like organic substance.

tration. For example, the world is in no danger of running out of iron. Many things, from the chlorophyll in green plants to the red blood cells in animals, contain iron. However, the iron cannot be extracted from either of those sources economically. Concentrated sources of iron are diminishing. Good sources of ore for metals such as tin are diminishing rapidly. It makes sense to conserve these metals by re-using them as often as we can and thereby eliminating waste. It makes no sense at all to mine a scarce metal like tin, or use a lot of energy to produce a metal like aluminum, only to have it buried in a landfill after a single use.

Lubricating Oils

In Alberta today, lubricating oils are usually discarded after they have been used only once. Approximately 120 million litres (30 million gallons) of lubricating oils are sold in Alberta each year. About one-fifth of it is lost during engine operation, about one-twentieth is used for dust suppression on rural roads and about one quarter is collected and re-refined. The rest is dumped indiscriminately on the ground, in the garbage, in sewers and perhaps even in streams. 65 million litres (16 million gallons) are presently being dumped each year.

Re-refined[1][2] oil may have better lubricating properties than new oil. Although lubricating oil tends to get dirty and become laden with heavy metals, grime, gasoline and water, the oil itself does not wear out. It has endured several thousand kilometers of engine operation, with the engine acting as sort of a refinery, burning off any inferior molecules.

New lubricating oil is made from a blending stock[3] which is distilled[4] from petroleum[5]. Additives[6] are mixed with the blending stock which make it lubricate better, last longer and keep the engine clean. Used lubricating oil can be processed to remove dirt, oxides and other impurities picked up during engine operation. The product is a re-refined blending stock which is as good as or better than new blending stock. Mixed with the same additives, the re-refined blending stock can be used to produce a lubricating oil equivalent to or better than new lubricating oil.

If used oil can be processed to attain a quality comparable with that of new oil, then why hasn't there been a widespread effort to utilize used oil as a resource?

At one time used lubricating oils enjoyed a wide market for re-use in vehicles, due to shortages and the high cost of new oil. These re-refined oils were sometimes of poor quality, and the processes used could not handle the more complex, high quality lubricating oils needed by modern high performance engines. But even as lubricating oils become increasingly complex and difficult to re-refine, new and better processes have been developed to replace the outdated methods. Although today's re-refined oils are well-suited for use in modern vehicles, the bad reputation of yesterday's inferior oils is still evident in public resistance to re-refined oils. New car warranties, stipulating the use of new oil, have fostered a belief that used oil is inferior in lubricating quality. The Canadian Armed Forces have prohibited the use of re-refined oil in tactical vehicles, which also serves to extend this false image of re-refined oil in the public mind.

The re-refining industry is handicapped in Canada by a tax structure which favours the processors of primary resources. Lubricating oil re-refiners do not receive some of the income tax benefits enjoyed by producers of new oil even though their products must compete.

As with any other recycling industry, the foundation of a viable oil re-refining industry is an adequate collection system. Successful re-refiners have become established only in areas of concentrated population, where used oil can be collected in sufficient quantities to offset collection costs. There must also be some effort on the part of service station

1 Refine - to purify and separate the various factions (oils of different weights) in petroleum, and to change or breakdown some elements in it, to produce specifically desired products.

2 Re-refining - the refining of used oil.

3 Blending Stock - a base product distilled from petroleum, from which commercially-available lubricating oils are manufactured.

4 Distill - to separate liquids with different boiling points from a mixture.

5 Petroleum - a mixture of tars, fuel oils, and other liquids formed over geologic ages by the decomposition of buried plants and animals.

6 Additive - any substance added to another to improve its qualities or performance.

Transferring used crank-case oil.

operators to keep oil separate from other liquid wastes, such as water and cleaning compounds. Municipal bylaws which restrict the disposal of waste oil have also encouraged recycling -- service stations solve their oil disposal problem by sending used oil to the re-refining industry.

The West German and Italian governments participate in used oil recycling, using rebate systems to encourage collection. Since 1968 the West German government has paid an incentive for collection with revenues generated by a tax on the sale or importation of new oils. The program is reported to operate satisfactorily and it discourages the dumping of oil simply by placing an economic value on it.

Reprocessing services for used oil already exist in Alberta. There are two oil re-refiners in the province; one in Calgary and one in Edmonton. Nearly 90 percent of the waste lubricating oil in these two cities is collected for re-refining. At least four other cities in Alberta have bylaws restricting the disposal of waste oil. Although these bylaws result in the collection of 40 to 60 percent of the used oil in these municipalities, most of it is dumped into landfills rather than being re-refined. The six cities in which waste oil is collected account for only one-third of the lubricating oil sold in Alberta. Much of the remainder is used in widely-scattered rural areas. This is a major barrier to the increased recycling of lubricating oil in Alberta.

As well as wasting a valuable resource, the disposal of used lubricating oil is a problem in terms of environmental pollution. Nearly three-quarters of the 80 million litres of lubricating oil sold yearly in Alberta eventually enters the environment along with any contaminants picked up during engine operation. If significant quantities were to find their way into water supplies, serious water quality problems could result. Concentrations as low as one part per million produce an odour and taste which make the water unacceptable for drinking purposes.

Waste oil also enters the environment as a result of its use for dust control on rural roads. This is not an efficient use of lubricating oil. Although control of dust on these roads is important, lubricating oil sprayed on road surfaces is not the most satisfactory way to do this. In fact lubricating oil has some properties which are exactly the opposite of those desirable for maintaining dust control on unpaved roads. It is estimated that 90

percent of the oil will be washed off the roads the first time it rains, ending up in the ditches and streams or nearby fields.

A comprehensive collection and recycling system for used oil would be of benefit in Alberta. The public should become aware of the resource value of used oil. That a useful resource should be lost and become a pollution problem is indeed a waste. Public acceptance of re-refined oil would be enhanced if governments found it acceptable for use in government vehicles. A 1974 report to the Environmental Research Trust observes: "other steps which could be taken (by governments) would provide incentives for collection: a subsidy to the re-refining industry, or low cost loans. There is clearly a need for government to meet with representatives of industry to develop a co-ordinated program. It would be fitting that Alberta, rich in resources, should recognize the value of recycling lubricating oils as a conservation practice."

Organics

The term "organics" refers to all material which is derived from plant or animal matter. It includes products derived directly from plants or animals such as wood, fruits, vegetables and fats. Petroleum products,[1][2] coal and natural gas are also organic, having formed over hundreds of thousands of years from decomposing[3] plant matter. Most household refuse is organic. It consists of paper products, food wastes, yard wastes and plastic (a petroleum product). Yard wastes can include grass cuttings, weeds, leaves or tree prunings. At the present time in Alberta, this material is being either burned or buried, except for some paper which is being recycled. This is an unfortunate wastage, as even organic material which cannot be recycled in its present form has many uses; four of these uses will be described here.

Refuse-Derived Fuel

There are several processes which can separate metals, glass, and other heavy non-organic objects from municipal garbage. The remaining, mostly organic, portion when dried and shredded is "refuse-derived fuel", a material resembling vacuum cleaner fluff.

Refuse-derived fuel is a clean-burning, low-sulfur solid fuel. While it does make a lot of ash and smoke, it does not produce polluting gases, nor the offensive odours of raw garbage. Generally, any furnace which can burn pulverized coal is also capable of handling refuse-derived fuel. The facilities which can burn refuse-derived fuel must have the equipment to handle the ash produced, and to remove the smoke from the gases before they leave the stack. Oil or gas burners generally do not have this type of equipment.

Burning refuse-derived fuel to produce steam is a very efficient way of using the energy contained in the organic matter. The steam-generating plant in St. Louis in the United States has had reasonable success in burning a concentration of 10 percent refuse-derived fuel with 90 percent coal. Steam made this way can be used directly for heating or can be used to generate electricity. They are currently building a plant for the latter in Toronto. Several American cities are building similar plants.

Pyrolysis

Any organic matter can be converted into a cleaner, more useful fuel through the process of pyrolysis or "destructive distillation". Pyrolysis is a process involving the chemical decomposition of organics at high temperatures in the absence of oxygen. Complex organic molecules break down, but do not burn, under such conditions, resulting in a variety of oils and gases, which can be used as fuel.

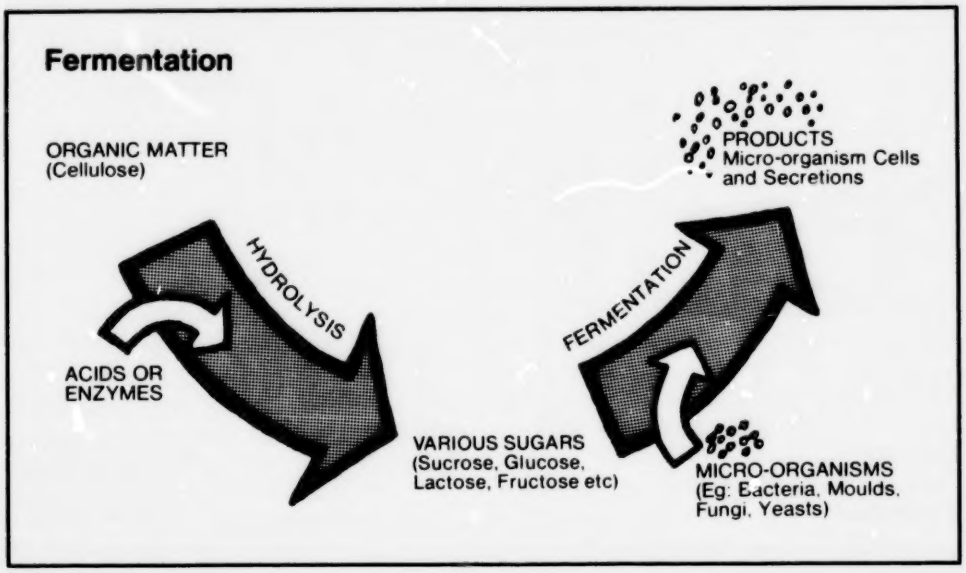
The technology involved in pyrolyzing organics is still new, and much work still has to

1 Petroleum - a mixture of tars, fuel oils, and other liquids, formed over geologic ages by the decomposition of buried plants and animals.

2 Petroleum Product - any product made from any of the ingredients of petroleum, or from any other petroleum products.

3 Decomposition - the decaying or breaking down of matter into smaller components or ingredients.

be done before this can be considered for wide scale usage. Three companies in the United States have developed processes to pyrolyze large quantities of municipal refuse. One of these generates steam, one produces a fuel gas and the other a fuel oil. However, the fuels produced are not as good as natural gas or petroleum-derived fuel oil. These processes are not very popular in North America yet, particularly in places like Alberta which have inexpensive natural gas and petroleum. They will probably become more popular as natural gas and petroleum supplies dwindle further. Other experiments in the United States and Europe are trying to develop a very closely controlled pyrolysis which can convert plastic, rubber or other organics into specific chemical products.



Fermentation

Fermentation is caused by the growth of micro-organisms[4] as they consume food materials and secrete byproducts. Most plant material consists of a considerable portion of cellulose[5]. The addition of acids or enzymes to the plant material causes the breakdown of the cellulose to sugars by a process known as "hydrolysis". These sugars provide food for micro-organisms which carry on the process of fermentation. The secretions[6] produced depend on the specific type of micro-organisms grown. Bacteria, fungi, molds and yeasts can all be used.

Fermentation is used today to produce alcoholic beverages, industrial chemicals, drugs such as penicillin, vitamins, and many food additives such as vinegar and citric acid. Methanol (wood alcohol), once commonly used as a fuel for heating and cooking, is a product of fermentation. Ethanol from fermented municipal garbage or agricultural waste may someday replace gasoline. Not only are the secretions of the micro-organisms useful, but sometimes the micro-organisms are useful themselves. Certain varieties of high protein yeasts may be grown and used for animal feed.

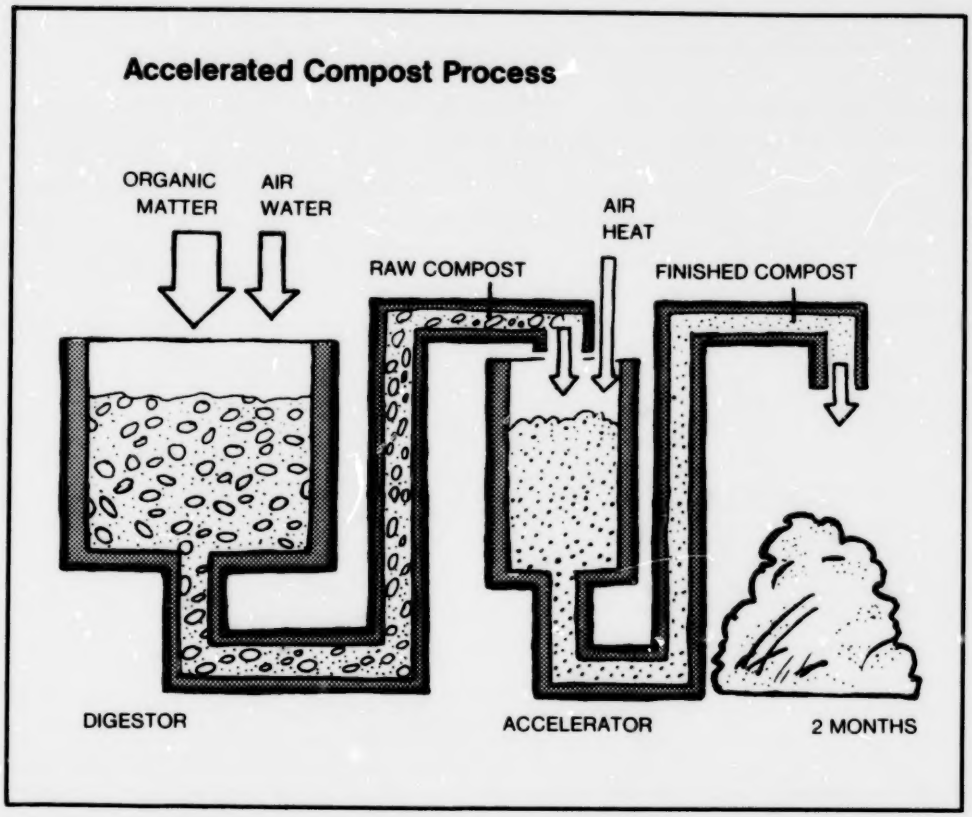
Any plant material can be fermented. Of course, the use of the end product will be limited by impurities[7] from the raw materials. Municipal garbage will never produce a vintage wine, but it can produce fuel alcohol or useful chemicals. Many waste products from agriculture, food processing, and forest-based industries are processed by fermentation to produce useful substances. The list of the products of biological fermentation, produced either commercially or experimentally, increases yearly.

4 Micro-organisms - microscopic living things such as bacteria, yeasts and many molds and fungi

5 Cellulose - a carbohydrate which forms the structure or walls of plant cells. Wood has very thick walls of cellulose, while leaves etc. have thinner walls

6 Secretions - substances produced and eliminated by any animal or plant, often as a waste product

7 Impurities - undesirable substances contained in any material



Composting

Composting is a biological process for converting organics into a stable humus[8]-like product. The process is odour-free and can be used in a back yard or in a plant which treats several tons of material per day. Compost supplies a small amount of nutrients, but its chief use is as a soil conditioner. It improves soil structure, provides air spaces in the soil, and increases water- and nutrient-holding capacity. It can also be used as a mulch[9] to protect the topsoil from excessive drying or erosion.

Any plant material can be composted: vegetable waste from the kitchen, leaves, lawn clippings, even small pieces of wood. All that is needed is moisture, air and the naturally occuring micro-organisms in the material. These micro-organisms will breakdown the plant matter into compost.

For back yard composting any simple enclosure will do, as long as there are holes in the bottom and sides to allow air circulation. Garbage cans, barrels, wooden boxes or wood frames covered with chicken wire can be used successfully. A cube with a lid and one removable side is best. It need not have a bottom, as the compost can sit directly on the ground.

In the autumn, save material from yard and garden clean-up and store in the enclosure until spring. In the spring start adding lawn rakings and clippings. Turn to mix new and old material. Keep moist but not soggy. Continue to add material throughout the summer, turning every week to add air. As the micro-organisms start to work, the pile will heat up, usually in about three days. If it doesn't heat up, turn less often. If foul odours form, it isn't getting enough air, so turn more frequently.

8 Humus - the decayed vegetable matter present in rich soil.

9 Mulch - any material which is spread over the ground surface between and under plants to keep the soil moist, protect roots and young plants, and prevent erosion.

Stop adding material by the end of August, but keep turning the pile and keep it moist to finish off the compost. It is finished when the pile will not heat up even though moisture and air are adequate. Finished compost should be uniformly dark and have an earthy odour. Mix it into the topsoil in the fall or save it to use as a mulch in the spring.

There are two plants in the United States currently producing compost on a commercial scale from municipal refuse. The process is similar to a back yard operation, but on a larger scale. However, it can be accelerated by the addition of heat, and need not take all summer. The refuse is shredded and heavy objects, such as glass and metal are removed. Shredded plastic doesn't detract from the quality of the compost. In fact it is especially good at creating air spaces in soil. The compost produced by these plants is sold for use in parks and recreational facilities, as well as for lawns and gardens. The use of compost is more prevalent in Europe than in North America, and as a result large scale composting plants are more successful there.

Plastic

Plastics make up about 10% of all household waste. More and more plastics are being used in products found commonly in the home. As a result there is an increasing amount of plastics entering the waste stream.

Plastics[1] are organic compounds, usually manufactured from petroleum products.[2 3] More and more uses are being found every day for the various kinds of plastic. Although many plastics look quite similar, they have different chemical properties. Because of this, the different types of plastic must be separated before recycling. The plastic in household refuse is generally a mixture of different types and colours. The various kinds of plastic are difficult to recognize by sight and, at this time, there is no process which can easily separate the mixture of plastics into the different types. Even if such separation were possible, each type would still consist of a number of different colours. The dyes which colour the plastic are difficult to remove so that, even if the plastic was melted down and reformed, the uses to which it could be put would be limited due to the inconsistant and mixed colour. All of this makes plastic recycling very difficult. There are also additives[4] added to many plastics during their original manufacture which create problems upon remelting. This complication makes the whole process of plastic recycling still more difficult.

It is possible to recycle some plastics, such as those used for telephones or athletic protection equipment (hockey helmets, etc.). These are of known types and quality, and are expensive enough to be worth the trouble of colour sorting. Telephone bodies are recycled in North America. Most plastic manufacturers save and recycle the scraps and left-over plastics within their plants. Again, these are of known type and re-usable colours. Otherwise the use of recycled plastic depends on the desired quality of the product. Some recycled material from other sources may be used if uniformity or strength are not important.

Generally in Alberta, raw materials are readily available and relatively inexpensive, so there is little recycling of plastics. Some companies have invented processes for re-using mixtures of plastics. One company in Japan and one in England are the only ones in this category actually re-using mixed plastics at this time. Another company in the United States is using a mixture of ground-up plastics instead of sand in concrete. They call their product "plastcrete". Japan and West Germany are experimenting with a pyrolysis process to break mixtures of plastics down into useful fuels or chemicals (see description of pyrolysis in "Organics" section).

All plastics are synthetic[5] substances made from petroleum products. Therefore, all plastics being used and thrown away represent a wastage of our petroleum resources. It is unfortunate to see this wastage, and much work is being done to develop new ways to recycle plastics. If all else fails, plastics may be burned. They are a very good fuel which gives off large amounts of heat. However, some produce pollution which could be harmful and which must be treated before being released into the environment.

1 Plastic - any man-made organic compound manufactured from petroleum products, which can be molded into shape when heated.

2 Petroleum - a mixture of tars, fuel oils, and other liquids, formed over geologic ages by the decomposition of buried plants and animals.

3 Petroleum Product - any product made from any of the ingredients of petroleum, or from any other petroleum products.

4 Additive - a substance added to any material to change or improve its properties.

5 Synthetic - man-made.

Rubber

Tremendous amounts of rubber[1] are disposed of every year in Alberta, mostly in the form of automobile tires. Nearly every one of our old tires eventually finds its way into a landfill. These tires create problems because they do not decompose and they are difficult to handle in a landfill. Due to their elastic properties, they have a tendency to work their way up through the buried refuse to the surface. This can happen while a landfill is being built up, or even years later if heavy equipment is used on the ground surface above them. For this reason rubber tires are already being stockpiled at some landfills even though there is no immediate plan for their use. Recycling rubber would not only prevent the waste of this petroleum-derived resource, but would also solve a disposal problem.

Work on finding uses for used tires is still in the development stage, but several different possibilities exist. One approach is to grind the tires into fine particules. A German company grinds tires mechanically into a powder. The rubber can be used as a substitute for new synthetic rubber in the manufacture of new tires. It can also be made into a flooring material which can withstand more intensive wear than linoleum, but is easier and cheaper to install than ceramic tiles. Such flooring is being used in Europe for shopping centres and airports.

A process being developed in the United States involves freezing the tires before grinding them. This process, unlike the German one, can handle the new steel-belted tires. The recovered steel can also be recycled. The American company is also developing the use of a mixture of ground rubber and asphalt for road surfacing. Specially designed equipment is required to mix this material, but the road surface created from it is capable of withstanding greater temperature differences and far greater wear than conventional road surfaces. The surface also provides better skid resistance.

Recycled rubber can be used in the manufacture of floor mats for use in industry and dairy barns, and for flooring in tennis courts. There is a variety of products which can be made economically from ground rubber, but use on roads is by far the largest potential market.

Several companies in the United States are investigating the possibilities of pyrolysis to convert rubber into a useable fuel. (See description of pyrolysis in "Organics" section.) The result is a kind of oil containing a number of useful chemicals or fuels.

In experiments in the coastal waters off the New England States, artificial reefs are being constructed from piles of used tires. These reefs become encrusted with corals and other marine animals, creating a fine new habitat for fish.

1 Rubber - an elastic, resilient synthetic material manufactured from petroleum, and resembling natural rubber.

Cloth

Most types of natural cloth fibre, such as linen, cotton, or wool, are recyclable. Used cloth and rags made from natural fibres can be shredded and the fibres rewoven into thread. Cloth produced with some recycled fibre can be just as good as cloth made entirely from new fibres. High quality writing paper can also be made from recycled cloth fibres.

The difficulty in recycling cloth today is that most fabrics are made either partly or entirely from synthetic materials such as "nylon", "orlon" and "polyester". Synthetic fabrics are difficult to recycle because, like plastics, the different materials are not easily distinguishable and so are difficult to separate. It would require a lot of work to sort through used clothes and other cloth products just to sort out the few recyclable items made from only one kind of fibre.

Shredded cloth and rags can be used, however, for stuffing furniture, toys, and other products. Used cloth is also being cleaned and used for cleaning rags. These, in turn, could be recycled again if collected and re-cleaned.

Barriers to Recycling in Alberta

In Alberta today only a small portion of the potentially recyclable material is being recycled. Most of the resources which have fulfilled their original purpose end up burned or buried as garbage. If we wish to increase the amount of recycling which is practiced in Alberta, we should first be familiar with the reasons why so little is being done today. We can then strive to change this situation.

Alberta, like much of Canada, has only a few large population centres with many towns and villages scattered over a wide area. The relatively small and widely distributed population of our province poses several problems which potential recycling operations must overcome. There are processes, such as the mechanical separation of municipal refuse[1] and recovery of recyclable resources, which are only economically feasible on a very large scale. This may mean that only the two largest communities in Alberta could support such a garbage processing plant. Smaller municipalities do not produce enough garbage to feed such a plant, and there is a limit to the distance unsorted garbage can be transported to one of these plants at a reasonable cost.

There are similar problems with the processing of recyclable materials, because much new equipment is usually needed. This means that a large volume of recyclable material is required to establish an economical size for a recycling plant. Some industries claim that the quantities of various recyclable materials produced in Alberta are too small to justify the capital expense[2] of a plant to process them. Often, even if the province as a whole produces enough of a recyclable product, transportation over long distances to a central plant would be too costly to make the operation economical. The alternative of shipping material to another province for recycling would be even more expensive and would involve high energy usage, which defeats the energy-saving purpose of recycling.

Despite the problems of supply and distance, there are many recyclable materials in Alberta which are present in great enough quantities to support a recycling industry, either locally in large centres, or in some cases even province-wide. Even so, there are obstacles to be overcome before an economically healthy recycling industry can be established.

Historically, industry in Alberta has been geared to primary resource usage rather than recovered resource usage. If recycling is to increase, a change of attitude will be needed on the part of industry, government and the people of Alberta. Many people mistakenly believe that recycled materials are inferior to new materials, a belief which is encouraged by the producers of new materials. This attitude hinders the sale of products containing recycled materials in competition with products made entirely of new material.

1 Mechanical Separation of Refuse - the (large scale) shredding or grinding and subsequent separation of municipal refuse into its components (paper, metal, glass, etc.).

2 Capital Expense - the outlay of money required to construct a new plant, or to expand or alter an existing one, including buildings, land and equipment.

Taxes and freight rates are still biased in favour of primary resource extracting industries. I these biases were to be reversed or at least eliminated, recycling would be more economical

The interest and participation of citizens will play a major role in making more recycling possible in Alberta. Since garbage sorting plants are not economical for most of the province, separation of various recyclable materials in the home is necessary if they are to be recycled. This requires separate containers for glass and metal, and the boxing or bundling of paper. These would then have to be delivered to a recycling depot[3], which consumes both time and energy, or collected separately by the municipality. Only four communities in North America, all in the eastern United States, now require home separation of materials in household garbage. A small number of municipalities in the United States and Canada collect newspaper separately. Generally, community experiments in separate collection have not succeeded in North America due to lack of citizen participation and/or a lack of markets for the collected materials. A number of factors -- usually lack of interest, financial incentive, or time -- seems to have deterred householders from taking part in these projects. But we have seen in the past that home separation is a possibility. In response to resource shortages during World War II, North Americans willingly separated valuable materials from their garbage. If their interest and concern could once more be aroused to motivate them, citizens would participate in efforts to prevent needless shortages.

3 Recycling Depot - a building or dropbox where recyclable material may be collected for eventual sale to a recycling plant.

The problem of developing markets for recyclable materials is rather complicated. Any industry will not be very eager to establish itself without a proven supply of the raw material it needs, but collection systems for recyclable materials are difficult to set into motion on a large scale without an established market. Both market and collection systems must be encouraged simultaneously.

Where Do We Go From Here?

Obviously there is more to recycling than donating old newspaper to community paper drives and taking empty bottles to the depots. Recycling is a way to make more efficient use of energy and more efficient use of resources. It is also an industry, subject to the constraints of supply, demand, and economics.

We in Alberta are very fortunate to have large supplies of natural resources, but many of these are non-renewable, and they will eventually run out. Simply because we appear to have abundance now is no excuse for waste. There are many things that can be done to increase recycling and decrease waste. Private citizens, industries, schools, elected representatives, and governments all have a part to play.

Groups of citizens can voice their concerns through the political process, at all levels of government, to encourage recycling programs. Citizens can also participate directly by supporting and cooperating with experimental programs in recycling or garbage separation in the home. We can also use our purchasing powers to influence industry. Refusing to buy wasteful packaging or non-recyclable containers will discourage the production of such items.

Municipalities, for their part, can examine methods to encourage the segregation of garbage in the home, such as providing separate garbage collection and reducing collection fees for those households cooperating. A more direct approach to the control of the amount of garbage generated can be seen in many European countries, where there are limits on the amount of garbage which will be collected. This influences peoples' buying habits as well as their garbage habits. Why buy extra garbage when disposing of it will be a problem? There is more recycling and less waste in all other countries in the world than there is in Canada and the United States.

At all government levels -- municipal, provincial and federal -- more recycling can be encouraged through financial incentives. Taxes, freight rates, and government purchasing practices are only some of the means by which these can be accomplished.

Universities, colleges and schools can become involved in a variety of ways. Universities, functioning as research centres, may encourage studies of both the social and technical aspects of recycling. All educational institutions can, through their programming, promote students' interest in, and knowledge of, recycling.

Finally, industry should recognize the opportunities present in recycling for both new and established businesses. It has already been demonstrated that recycling can be profitable to business as well as to society. There are also opportunities for improvement in product design and packaging, so that the articles produced will have a re-use value, will last longer, or will be more easily recyclable. This may be the beginning of a change in our current wasteful production and consumption patterns. Although for some products such redesign can be encouraged by the economics of the recycling industry, for most products such changes will only come about as a result of public demand.

In order to preserve our standard of living, and much of our way of life for the future, we must make some accommodations in our lifestyles which will reduce waste. We must begin to reduce unnecessary or wasteful uses of resources and to retrieve the resources which we now discard. As the basic foundation of all our industries and consequently our economy, our natural resources are the only genuine currency we have. No matter how abundant they may be, there is an inevitable limit to all non-renewable resources, and to the rate at which renewable resources can be replaced.

Depleting oil and gas give a particular focus to conservation in this province. These resources now allow for much of our current prosperity. Within the life time of most of us these two resources may no longer be abundant. By squandering them today we are robbing tomorrow.

Our resources include not only physical commodities, like petroleum or timber, but also such genuine assets as clean air and clean water. We may lose the use of these less tangible resources without efforts to make the most efficient use possible of the physical resources we take from the earth.

Alberta has the potential to conserve both its material resources and its quality of life, through the combined efforts of all Albertans. We need to recognize the long term value of our resources and to appreciate the true cost of waste. Through recycling we are paying into a savings account of resources for the future.

For Further Information

1 **A National Survey of Resource Recovery Activities** by Richard Hooper, United States Environmental Protection Agency, publication number SW-142, January, 1975.

2 **Let it Rot! The Home Gardener's Guide to Composting** by Stu Campbell (Garden Way Publishing, 1975).

3 **Recycling - Re-Using Our World's Solid Wastes** by James and Lynn Hahn, (Franklin Watts, Inc., 1973).

4 **Recycling Resources** by Lawrence Pringle. (Macmillan, N.Y., 1974.)

5 **Salvage Markets for Materials in Solid Wastes** by Arsen Darnay, United States Environmental Protection Agency, publication number SW-296, 1972.

6 **Solid Waste Management Problems and Perspectives** by Hersch Jacobs and Asit K. Biswas, Policy Planning and Research Service, Environment Canada, 1972.

7 **The Garbage Book**, office of Energy Conservation, Energy, Mines and Resources Canada, June, 1976.

8 **Waste Resources Edmonton**, by Jean Frost, **et.al.**, Interdisciplinary Committee for Environmental Quality, University of Alberta, 1974.

9 Alberta Environment Library on the 14th Floor of Oxbridge Place, 9820 - 106 St., Edmonton, Alberta is a good source of information on recycling and recovery of resources from municipal refuse.

10 Any public school or university library should have some information on recycling. Check the subject catalogue under the headings "recycling", "solid waste" or "resource recovery".

12 Look through indexes or back issues of magazines such as **Alternatives**, **Environment**, **Solid Waste Management**, **Waste Age**, **Compost Science**, and **Resource Recovery and Conservation** which may be available at your library.

For more information:

Waste Management Branch
Pollution Control Division
Alberta Environment
4th flr., Oxbridge Place
9820 - 106 Street
Edmonton, Alberta T5K 2J6
Telephone: 403/427-5868